PGG 10035

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546
TELS. WO 2-4155
WO 3-6925

FOR RELEASE: TUESDAY A.M.
February 15, 1966

RELEASE NO: 66-31

PROJECT: 260-INCH SOLID ROCKET MOTOR

PRESS KIT

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TO BE LAUNCHED NO EARLIER FEBRUARY 23, 1966.

N.E.W.S. NASA
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SECOND 260-INCH SOLID MOTOR SET FOR TEST FIRING

The second 260-inch diameter solid rocket motor, the nation's largest, will be test fired in Dade County, Fla., no earlier than Feb. 23. It is expected to produce more than 3.6 million pounds of thrust.

The experimental motor, more than 22 feet in diameter and 80 feet long, is part of the large solid motor technology program conducted by the National Aeronautics and Space Administration.

The first 260-inch motor was successfully test fired last fall. That two-minute firing produced a peak thrust of 3.6 million pounds and an average thrust of nearly 3 million pounds.

The second firing will help show the repeatability of the firing, prove that manufacturing techniques are reliable and demonstrate that the motors can be produced at a predictable cost.

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The nighttime firing is expected to be visible for nearly 100 miles. Its flame and smoke will reach 7,500 feet into the air and produce more than 3 billion candlepower of light.

OBJECTIVES OF PROGRAM

Objectives of the large solid motor project are to advance technology and to demonstrate the feasibility of building and operating solid motors of greater size than those in current use. Such motors have certain advantages of simplicity and attendant low cost.

The second firing will complete the current 260-inch motor contract and will mark the initiation by NASA of a sustained solid motor technology effort aimed at additional testing of systems, materials and new propellants.

Large solid rocket motors have a potential for use in multistage launch vehicle systems carrying heavy payloads into space.

The first two-minute firing of the 260-inch motor last fall tested the strength of the maraging steel motor case, the structural integrity of the cast propellant, the insulation and the ablative nozzle.

Only minor changes were made in the second motor. Sidewall insulation in the case was increased one-tenth of an inch and the igniter tower was modified slightly.

This second motor, designated SL-2, will again be fired in a nozzle-up position. It is held in a test pit more than 160 feet deep with only the nozzle protruding above ground.

The SL-2 motor was built under contract to NASA's Lewis Research Center by Aerojet-General Corporation's Solid Rocket Operations Division at Sacramento, Calif.

The rocket motor casing is made of maraging steel, a new alloy containing about 18 per cent nickel. The case, built by the Sun Shipbuilding and Dry Dock Company, Chester, Pa., is 60 feet, 3 inches long and weighs 60 tons before it is loaded.

After manufacture and hydrotesting, the motor case was shipped by barge down the East Coast and through the Inland Waterway to the Aerojet site in Florida.

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Nozzle 20 Feet Tall

The nozzle, manufactured by TRW Inc.-Structures Division, Cleveland, Ohio, stands 20 feet tall and is more than 15 feet in diameter at the widest point. Ablative materials are used throughout all areas exposed to the exhaust gases. These gases reach temperatures above 5,500 degrees F.

The propellant, cast in a single piece, or grain, is placed inside the motor case after the case has been installed in the firing pit. The polybutadiene, aluminum and ammonium-perchlorate propellant weighs 1,680,000 pounds and burns at a rate of six tons per second.

Igniting the 500,000 square inches of propellant grain requires the use of another solid rocket motor that generates 250,000 pounds of thrust. The igniter fires an 80-foot flame which ignites the entire length of the larger motor at the same time. The igniter then is removed by allowing it to fly itself upward from the nozzle of the larger motor. Tethered by huge steel cables, it swings through a controlled arc and plunges into a large nearby pond.

The 260-inch solid rocket motor program, initiated by the Air Force in 1963, was transfered to NASA in mid-1964. It is directed by the NASA Office of Advanced Research and Technology.

BACKGROUND

The Large Solid Rocket Motor Program is a national effort to advance the technology of solid propellant motors for possible future application to space missions of the National Aeronautics and Space Administration and Department of Defense.

The 260-inch program was initiated under the management of the Air Force's Space Systems Division in 1963. In mid-1964 it was transferred to NASA and management responsibility was assigned to the Lewis Research Center in Cleveland, Ohio. The Air Force retained the portion of the program related to 156-inch solid motors, considered the largest practical size for land mobility, an important aspect of defense requirements.

Three sizes of solid motors have been fired under the 260 program. In September 1964, a 120-inch diameter motor was fired by Aerojet at its Dade Division. It produced about 600,000 pounds of thrust. A 156-inch motor was fired by Thiokol Chemical Corp. at Brunswick, Georgia, in 1965. This was the first solid propellant motor to produce 3 million pounds of thrust.

Short Length Motors

The SL-2 is the second of two short-length motors to be built and tested under the current program. These are called short length motors because they are approximately half as long as a motor required for an actual mission. A full length motor would range from 120 feet to 200 feet and produce 5 to 8 million pounds of thrust. Actual length would depend on the particular mission.

The first 260-inch motor SL-1 was fired Sept. 25, 1965, at the Dade Division of Aerojet General. Data from some 120 channels of instrumentation showed the rocket averaged nearly 3 million pounds of thrust during its "steady state" operation.

SL-1 achieved:

1. peak thrust of 3.6 million pounds
2. average thrust of 2.9 million pounds
3. action time of 128 seconds (this is the period in which the motor is producing useful thrust.)
4. web action time of 112 seconds (this is the steady state operation period in which the motor is running at or near peak thrust.)
5. total power of more than 325 million pound-seconds.

The firing was a complete success and resulted in no major changes to be made to the second motor. There was only a slight discoloration on the outside of the case in some areas

which appeared after the motor firing. This indicated the insulation should be a tenth of an inch thicker and insulation was added for SL-2.

A number of materials problems had to be overcome in the fabrication of 260-inch motors. One problem was the case itself. Because of its huge size it was not economically sound to build a furnace large enough to heat-treat the case at 1,600 degrees F. as is normal for high strength steels.

Maraging Steel Chosen

To overcome this problem a maraging steel was chosen for the case. This type of steel contains 18 per cent nickel, eight per cent cobalt and five per cent molybdnum, providing a minimum yield strength of 200,000 pounds per square inch with heat treatment to only 900 degrees F.

Aerojet used the tungsten inert gas (TIG) welding process. With this method, models tested to destruction proved the case would withstand design pressures. This was later borne out by hydrotests and by the first 260-inch firing last fall.

The cases were fabricated for Aerojet by Sun Shipbuilding and Dry Dock Company at its Chester, Pa. facility.

The nozzle for the 260-inch motor was built by TRW Inc. of Cleveland, Ohio. It is an ablative nozzle 20 feet high with a throat diameter of about six feet and nozzle exit of about six feet and nozzle exit of about 15 feet. The structural material for the nozzle is stainless steel backed with aluminum honeycomb. The ablative material is carbon impregnated with phenolic and silica.

IGNITER MOTOR

The igniter is another smaller solid rocket motor which fires into the throat of the SL-2. It develops a quarter of a million pounds of thrust itself and produces an 80-foot flame to ignite the 500,000 square inch propellant surface area all at once.

About one-half second after ignition, the igniter flies itself out of the SL-2 nozzle and is guided by cables to a nearby impact pond.

During the first firing the igniter broke loose from its cables and came down beyond the impact pond. Because of the large forces involved it is difficult to restrain the igniter motor. The track which holds the igniter in place in the nozzle has been shortened 15 feet for this firing.

This will allow the igniter to leave the stream of exhaust gas from the large motor earlier and increase the chances of restraining it.

The tower and igniter track are retracted before T-plus-6 seconds.

As a sidelight, the igniter for the igniter motor weighs 100 pounds and produces 4,500 pounds thrust.

INSTRUMENTATION

SL-2 is heavily instrumented and reports back more than 120 channels of information. Thermocouples for measuring temperature and strain gauges are distributed over the case and nozzle. Gas pressure is measured at the closed end of the motor. Accelerometers are used to measure vibration including acoustic effects.

The motor itself rests on three special load cells to measure thrust during the firing. The load cells have demonstrated accuracies of better than plus or minus one half of one per cent in measuring loads up to five million pounds.

SL-2 FACT SHEET

1.	Total weight:	931 tons (1,862,802 pounds)
2.	Length:	80 feet, 8 inches
3.	Thrust:	3.6 million pounds at sea level
4.	Chamber Length:	60 feet, 3 inches
5.	Chamber Diameter:	21 feet, 8 inches
6.	Insulation:	10 tons of asbestos-filled rubber varying in thickness from 4.5 inches to 3 tenths of an inch.
7.	Propellant:	Aluminized composite PBAN (polybutadiene, acrylonitrile, acrylic acid)
8.	Grain Design:	Cloverleaf
9.	Propellant Surface Area:	500,000 square inches

10.	Burning Temperature:	5,500 degrees F.
11.	Propellant Weight:	1.68 million pounds
12.	Case Materials:	Maraging steel, 200,000 pounds per square inch minimum yield strength
13.	Nozzle Materials:	Maraging steel shell lined with ablative plastics. Structural material for exit cone is metallic honeycomb
14.	Nozzle Size:	20 feet, 5 inches tall. Weight 16 tons. Throat diameter approximately 6 feet. More than 15 ft. at widest point.
15.	Igniter Thrust:	250,000 pounds
16.	Burning Time:	130 seconds
17.	Web Action Time:	114 seconds
18.	Burning Rate:	12,000 pounds per second, or approximately one half inch of propellant thickness per second
19.	Predicted Performance:	Average thrust of 3 million pounds over the 114 seconds of web action time.

SEQUENCE OF FIRING EVENTS

T plus 0	Ignition
T plus 1/2 second	Igniter begins to leave large motor
T plus 1 second	Motor fully ignited; igniter emerges from nozzle
T plus 42 seconds	Maximum chamber pressure and thrust achieved
T plus 114 seconds	End web action time, burning begins tailoff
T plus 170 seconds	Quench boom lowered. Carbon dioxide and water are used to extinguish the remaining propellant.

260-INCH MOTOR TEAM

The Large Solid Rocket Technology Program is directed in NASA Headquarters by the Office of Advanced Research and Technology. Dr. Mac C. Adams is Associate Administrator for OART. Adelbert O. Tischler is Director of the Chemical Propulsion Division and William E. Cohen is Chief of the Experimental Motors Branch. Robert A. Wasel is Headquarter Program Manager.

Directing the project at Lewis is Bruce T. Lundin, Associate Director for Development. James J. Kramer is Project Manager.

INDUSTRIAL TEAM

Aerojet General Corporation is prime contractor for the 260-inch solid propellant motor.

Sun Shipbuilding and Dry Dock Company of Chester, Pa. constructed and tested the huge rocket case.

TRW Structures Division fabricated the ablative nozzle parts and assembled the various sections into the single 20 foot long nozzle.

Other subcontractors include:

Ladish Company	Cudahy, Wis.
Goodyear Tire and Rubber Co.	Akron, Ohio
Hef Division, Hooker Chemical Corp.	Columbus, Miss.
Aluminum Corporation of America	Alcoa, Tenn.
U.S. Rubber Company	Baton Rouge, La.
Reichold Chemical Company	Cambridge, Mass.
Dow Chemical Company	Freeport, Tex.
American Hoist & Derrick Co.	St. Paul, Minn.
Republic Steel Corporation	Cleveland, Ohio
Allegheny-Ludlum Steel Corp.	Pittsburgh, Pa.
Cameron Iron Works	Houston, Tex.
Fiberite Corporation	Winona, Minn.
National Cylinder Gas	Miami, Fla.
Kaiser Aluminum Corporation	Spokane, Wash., and Ravenswood, W. Va.

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